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MIS3 edge-ground axes and the arrival of the first *Homo sapiens* in the Japanese archipelago

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ABSTRACT

A lithic assemblage with edge-ground axes appeared in the Japanese archipelago in MIS3, about 38,000 cal BP, and continued to about 32,000 cal BP. This period corresponds to the early part of the early Upper Palaeolithic (eEUP). To date, similar stone axes have not been reported in Upper Palaeolithic sites in the continental regions of China, Korea, and Russia. These edge-ground axes appear to be independent inventions of the first *Homo sapiens* to settle the Japanese islands, and they are one manifestation of modern human behavior.

The larger edge-ground axes appear to have been used for felling trees and for modifying wood. When the blades were damaged, these axes were reworked into smaller forms and reused for processing hide. The flake tools that were parts of the same lithic assemblages as the axes were probably hunting tools, but presently there is no evidence they were used for hunting the large mammals, such as Naumann's elephants, that inhabited the Japanese islands at that time. Some of these flake tools were made of obsidian obtained from an island in the Pacific off the coast of Japan, demonstrating these early inhabitants of the Japanese islands had some kind of watercraft for crossing ocean waters. This is also a type of modern human behavior. Further, around 40,000 cal BP there was no land connection between the continent and Japan, so these first *Homo sapiens* settlers of the islands had to arrive by crossing water.

The humans possessing these edge-ground axes formed circular settlements which they inhabited seasonally. They most likely had a clear awareness of group and of cooperative behavior.

1. Introduction

Based on the dating of the oldest archaeological sites, *Homo sapiens* arrived in the Japanese archipelago in Marine Isotope Stage 3 (MIS3), about 38,000 cal BP. *Homo sapiens* developed new types of behaviors not seen in earlier humans, and they used these behaviors as survival strategies to spread out of Africa to all parts of the Earth. These new behaviors are called "modern human behaviors," and they include abstract thinking, superior planning abilities, innovativeness in actions, economic activities and technology, and manipulation of symbols (McBrearty and Brooks, 2000). These "modern human behaviors" are seen in archaeological evidence from *Homo sapiens* sites in varied regions around the world.

The purpose of this paper is to discuss the modern human behaviors of *Homo sapiens* in mid-latitude East Asian Japan, through the stone tool assemblages containing edge-ground stone axes. In world history, ground stone axes are well known as characteristics of the Neolithic. However, *Homo sapiens* in the Japanese islands developed and used the grinding (polishing) technology in the early part of the early Upper Palaeolithic (eEUP), before 20,000 years ago. Looked at from the opposite point of view, the production and use of these refined edge-ground axes demonstrate the presence of *Homo sapiens* in Japan.

The humans in the Japanese islands in MIS3 did not leave any great works of art on the walls of caves as did some of their European contemporaries, but they did independently develop the technique of grinding to produce stone axes as part of their survival strategy. However, researchers who are not well-versed in the archaeology of Japan probably are not aware that the Upper Palaeolithic peoples here possessed ground stone axes. This article first clarifies the stratigraphic provenience and dating of edge-ground axes. Then, it discusses the morphological characteristics and uses, the other stone tools and stone materials in the associated assemblages, the sociology of the human groups using these axes, and the process of *Homo sapiens* spreading into the Japanese islands.

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Fig. 1. Edge-ground axe from the Hinatabayashi B site (Tani, 2000).

2. Stratigraphic provenience and dating of edge-ground axes

2.1. Definition and distribution of edge-ground axes

Edge-ground axes are defined as stone tools made on pebbles or flakes retouched into the shape of axes, with grinding centered on the blade (Fig. 1). Edge-ground axes are known in two Japanese prehistoric periods: the early part of the early Upper Palaeolithic (eEUP) and the much later Incipient Jomon Period. From Earliest Jomon on, not only the blade but the entire axe was produced by grinding. This article is limited to the eEUP. Archaeological sites of the eEUP yield both edge-ground stone axes and whetstones that were used to produce sharp blades on the stone axes (Fig. 2). These same sites also yield unground chipped stone axes. These chipped axes have varied shapes and few have any signs of use wear. Most likely, these chipped axes are blanks for producing edge-ground axes.

Fig. 2. Edge-ground axe and whetstone from the Hinatabayashi B site (Tani, 2000).

To date, a total of 896 edge-ground and chipped stone axes have been found in 224 sites belonging to the eEUP (Hashimoto, 2006). These sites are found from Kyushu in the west through Honshu in the east (Fig. 3), but none are reported in Okinawa in the south or Hokkaido in the north. However, similar Upper Palaeolithic edge-ground axes have not been found in China, Korea or Russia, the three countries neighboring Japan. These stone tools appear to be independent inventions in the Japanese islands.

2.2. Stratigraphic provenience and dating

All the dates used in this article were calibrated with IntCal09 (Reimer et al., 2009). The Aira-Tn tephra (AT) covers all of Japan except Hokkaido and Okinawa, and it has a date of 29,000 cal BP.

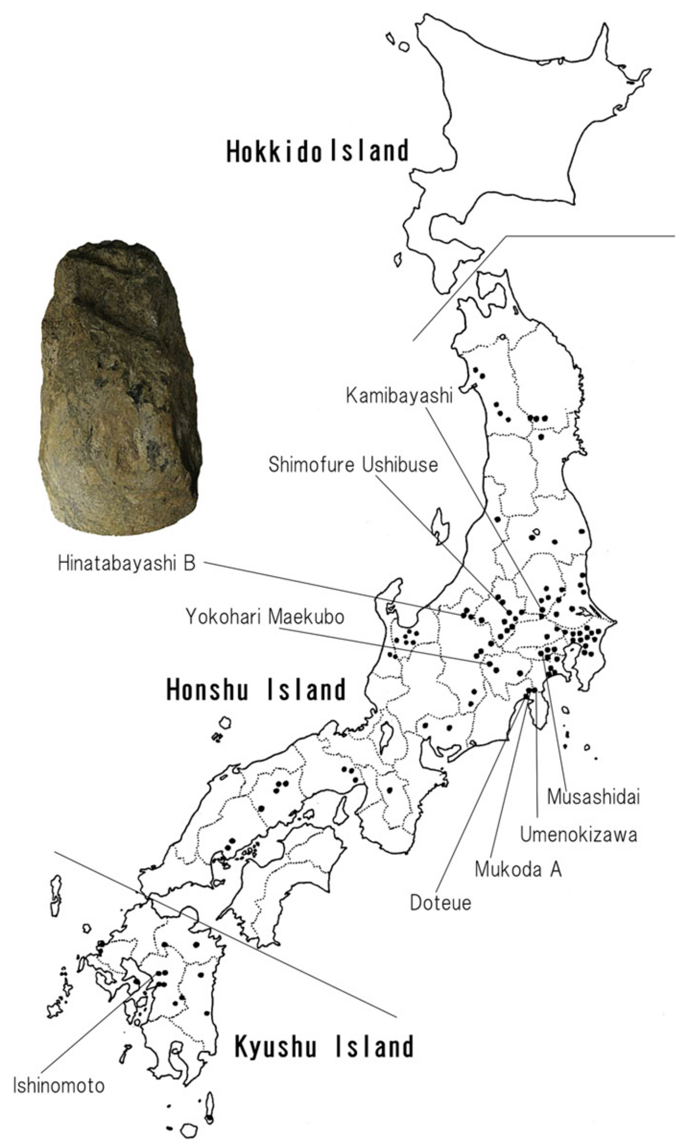

Fig. 3. Distribution of early Early Upper Palaeolithic (eEUP) sites in the Japanese Archipelago.

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This tephra marks the boundary where the Palaeolithic stone assemblages change considerably. Consequently, the AT tephra is used as the key stratum dividing the Japanese Palaeolithic into an early half (EUP) below AT and a late half (LUP) above AT. This archaeological boundary dates exactly to the MIS3-MIS2 boundary.

All edge-ground stone axes in the Japanese Upper Palaeolithic come from strata below AT. A typical example are the sites in Shizuoka Prefecture on the flanks of Mt. Hakone-Ashitaka, where loam deposits derived from Mt. Fuji are thick (Fig. 4) and the axes are found in stratigraphically clear, well-dated contexts. In this region of Japan, there is about 1 m of Holocene black soil over the Pleistocene Upper Loam (Tachikawa Loam). The eEUP begins at the base of the Upper Loam, about 4 m below the surface. The Upper Loam has alternating lighter colored strata, blackish strata called "Black Bands" (BB), and scoria strata. The upper-most stratum is the Yasumiba layer, below which are several black bands (BB0 to BBVII), six scoria layers (SC1 to SC6), and the NL layer which includes the AT tephra.

Fig. 5. Axes in situ in the Umenokizawa site (Sasahara, 2008).

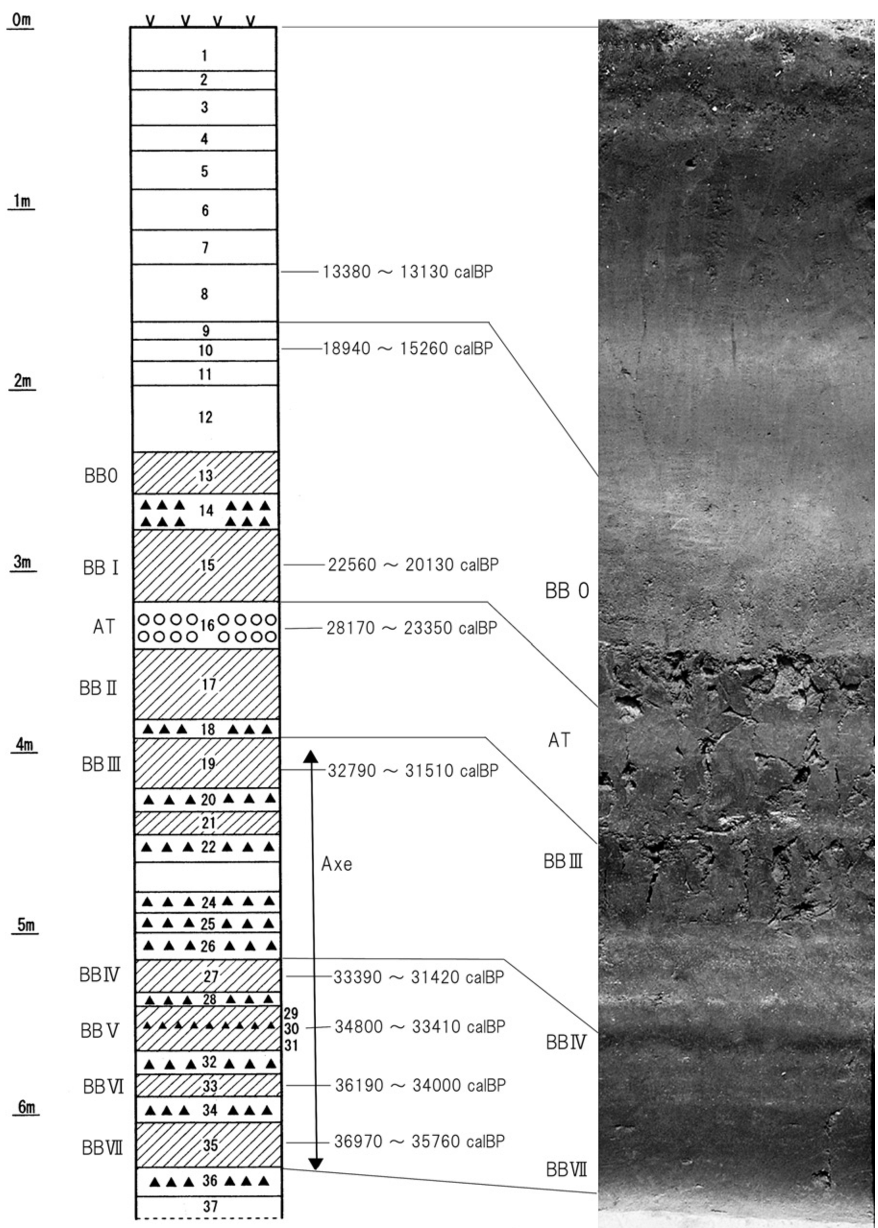

Fig. 4. Stratigraphy, dates and provenience of stone axes in sites on the flanks of Mt. Hakone-Ashitaka (Shizuoka Prefectural Archaeological Research Institute, 2004).

Table 1
Radiocarbon and calibrated dates for early Early Upper Palaeolithic sites.

No.	Site	Conventional C14 BP	Calibrated C14 BP	
			2σ (95.4.)	
			From	To
1	Fujiishi	32060 ± 170	36970	35760
2	Umenokizawa	29920 ± 320	35120	33670
3		29650 ± 340	34900	33390
4		29590 ± 340	34850	33350
5		28810 ± 290	34520	32470
6		28380 ± 240	33380	31820
7	Mukoda A	29010 ± 190	34490	33100
8		29460 ± 200	34660	33480
9	Hinatabayashi B	31420 ± 280	36540	35160
10		29870 ± 250	35060	33850
11		29820 ± 250	34990	33720
12		29640 ± 240	34790	33540
13		28540 ± 220	33600	31960
14		28400 ± 210	33350	31920
15		28230 ± 210	33180	31730
16		27950 ± 210	32840	31510
17		27940 ± 200	32810	31510
18	Ishinomoto	33720 ± 430	39940	37180
19		33140 ± 550	39090	36580
20		31460 ± 270	36550	35180

(calibration done with IntCal09, Reimer et al., 2009).

Stone axes are found only below the AT layer, from BBIII to BBVII. The edge-ground axes from BBVII were found at the Fujiishi site (Abe, 2009). The radiocarbon age of BBVII is 32,060 ± 170 BP (36,570 cal BP). At the Umenokizawa site, 8 axes were recovered from the younger BBVI layer (Fig. 5). Five pieces of charcoal from BBVI were radiocarbon dated (Sasahara, 2008). These gave consistent dates between 29,920 ± 320 and 28,380 ± 240 BP (34,540–32,660 cal BP), or roughly 34,000–32,000 cal BP. The youngest edge-ground axes come from BBIII at the Mukoda A site (Togashi, 2007), which has radiocarbon dates from 29,460 ± 200 to 29,010 ± 190 BP (34,410–33,710 cal BP). These dates are not much different from the dates for BBVI, so the age of BBIII is probably about 34,000–33,000 cal BP. In short, the edge-ground stone axes from sites on the flanks of Mt. Hakone-Ashitaka span the time from 36,000 to 32,000 cal BP.

The Hinatabayashi B site in central Honshu (Tani, 2000) yielded 60 stone axes. Ten pieces of charcoal associated with these axes gave consistent dates (Table 1) between 31,420 ± 280 and 27,940 ± 200 BP (35,850 to 32,130 cal BP), or roughly 35,000–32,000 cal BP. The stone axes from the Ishinomoto site in Kyushu (Ikeda, 1999) are associated with radiocarbon dates between 33,720 ± 420 and 31,460 ± 270 BP (38,500 to 35,880 cal BP). These dates of roughly 38,000–35,000 cal BP are older than the dates from sites on Honshu to the east. More dates are needed for certainty, but at present the dates suggest that edge-ground stone axes originated in Kyushu at the western end of the Japanese archipelago.

Fig. 7. Breakage on a stone axe from the Hinatabayashi B site (Tsutsumi, 2006).

To summarize, in the Japanese archipelago edge-ground stone axes first appeared about 38,000 cal BP in the late half of MIS3 and disappeared about 32,000 cal BP before the end of MIS3. Edge-ground stone axes did not continue to 29,000 cal BP and the beginning of MIS2.

3. Edge-ground stone axes

3.1. Functions

The question of what activity or activities these edge-ground stone axes were part of, what technological purposes they served, is fundamental to understanding the adaptation of the first *Homo sapiens* in the Japanese archipelago.

The Hinatabayashi B site yielded 60 stone axes, the largest number from any one site of this period. Of the 60 axes, 36 were edge-ground axes, 4 were chipped axes, and 8 were missing the blade and hence could not be classified. There also were 12 axes with naturally edge-ground surfaces that would serve the same function as axes with blades ground sharp by humans. Smoothly ground, sharp blades would reduce the friction of the tool when penetrating the material it was used against (Sahara, 1993). Therefore, the chipped axes are probably not finished products.

The 36 complete edge-ground axes from the Hinatabayashi B site showed the following kinds of damage: the blade was badly damaged on 7 axes (19%) (Figs. 6-1 and 7). The blade had at least a small amount of damage on 9 axes (25%) (Fig. 6-2). No damage

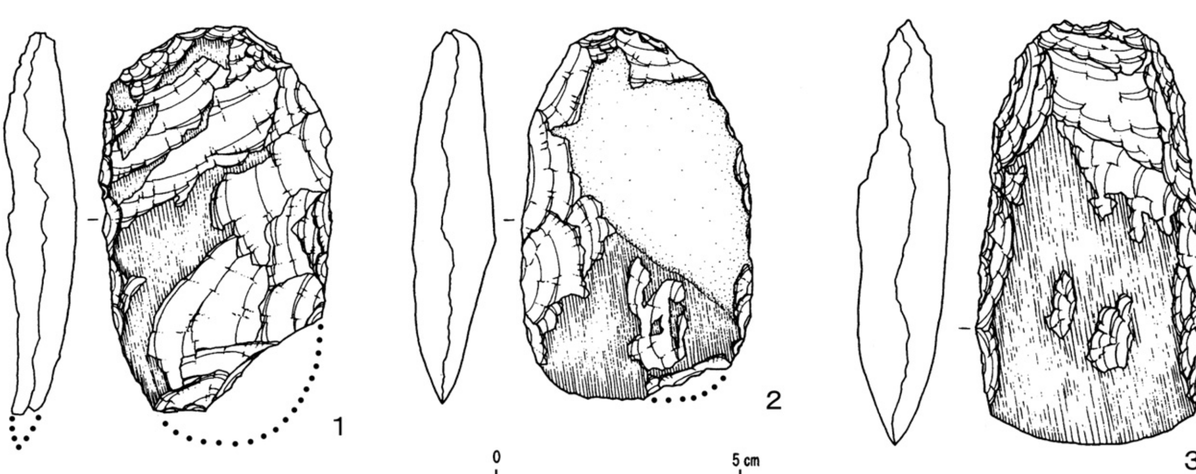

Fig. 6. Breakage patterns on stone axes from the Hinatabayashi B site.

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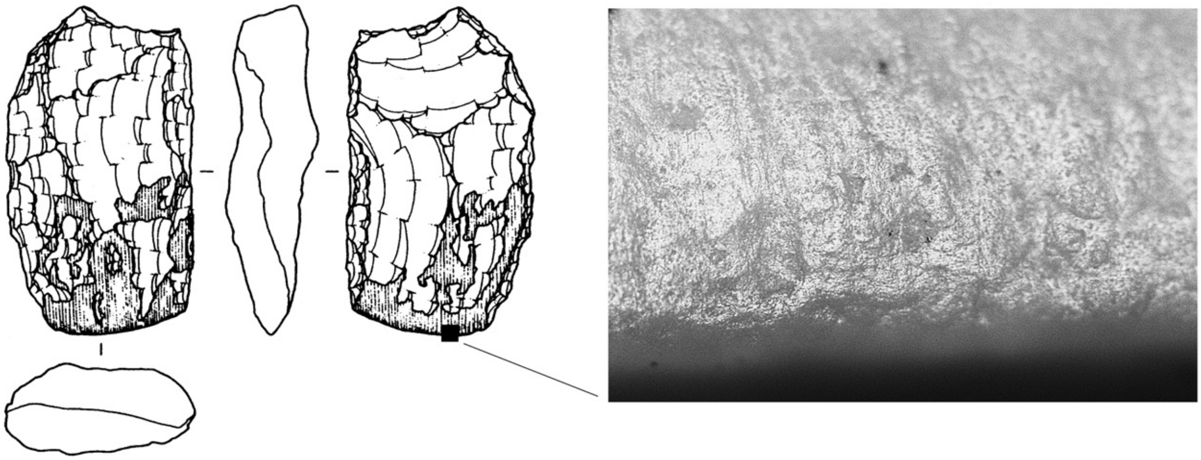

Fig. 8. Use wear on a stone axe from the Hinatabayashi B site: Polish from working hide (Tsutsumi, 2006).

was apparent on the blades of 20 axes (56%). In total, 44% of the edge-ground axes had some degree of damage on the blade. Those with considerable damage (Fig. 7) clearly were used against a hard material. The most likely use of these axes would seem to be felling trees and modifying wood for some use.

In contrast to the obvious damage on the blades of the larger stone axes, there is little evidence of damage on the blades of the smaller ones. The use of a metallurgical microscope at 100–500 power magnification to study the various marks resulting from stone tool use, in order to infer the possible prehistoric functions of stone tools, is called microwear analysis. This method was pioneered in the 1970s by Lawrence H. Keeley, then at Oxford University, through experiments to determine the kinds of use wear produced by using stone tools against various kinds of materials (Keeley, 1980). Keeley's method is now the standard for studying stone tool functions.

The Hinatabayashi B axe blades were examined under 100–200 power magnification with a metallurgical microscope (note 2). The smaller axes had the luster (Fig. 8) characteristic of tools used to process hide (Tsutsumi, 2006). In other words, among the smaller axes there are ones used for delicate work, unlike the hard striking work the larger axes were used for. Use wear analysis of the stone axes from the Minami Sanrizuka Miyahara 1 site (Takahashi, 2004) and the Ryusuijiura site (Iketani, 2004) showed the same two types of use wear: hard striking and hide working. The stone axes from the Hinatabayashi B site varied in size (Fig. 9), but this probably was not the original state. Probably when the large axes were broken during heavy-duty activities, such as felling trees, they were reworked into the smaller tools and used for processing hide. In fact, this process is evident in refitted pieces (Fig. 10) found at the Musashidai site (Yokoyama, 1984).

Nagasaki (1990) suggested these edge-ground stone axes were specialized tools for the active use of wood – exploitation of the forest. Sato (2006) interpreted these eEUP edge-ground axes as heavy-duty tools used for producing wooden handles and construction materials for dwellings, based on the extreme damage they incurred during use. These tools could have been first used to clear a space for the circular camps, and then they were used as Sato (2006) says for making handles and construction materials (Tsutsumi, 2006). The smaller axes would not hold up for this hard duty, but were used instead for softer duties such as hide processing.

Among the charcoal from the Hinatabayashi B site that was used for dating, some was identified as *Picea* (spruce) and other conifer species (Fujine, 2000). These are probably the kinds of trees being cut with the axes. This type of forest is presently found at an altitude of 1500–2500 m, well above the 650 m altitude of the site. This type of environment for the site at the time of occupation (eEUP) matches with the colder conditions of the late half of MIS3, before the beginning of MIS2.

Development of edge-ground stone axes by the first *Homo sapiens* in the Japanese islands thus appears to be an independent invention for adapting to the MIS3 forest environment these early human settlers of the islands encountered.

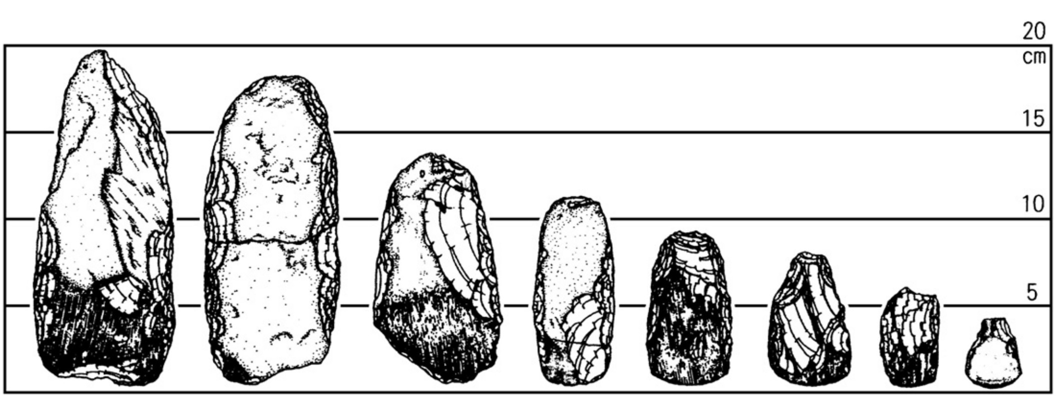

Fig. 9. Sizes of stone axes from the Hinatabayashi B site (Tsutsumi, 2006).

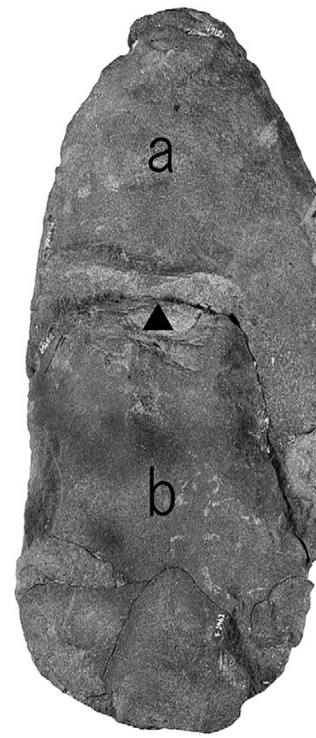

Fig. 10. Modification of a stone axe from the Musashidai site (Kosuge, 2006). (Explanation: axe **a** lost part ▲ which was modified into the smaller axe **b**.).

3.2. Lithic assemblages and stone tool functions

The following are some thoughts on the composition of the stone tool assemblages that include the edge-ground axes. Flake tools of the Japanese Palaeolithic can be classified as shown in Fig. 11, based on the type of material used, the type of retouching, and the location of retouching (Yamaoka, 2006). The main flake tools in the eEUP assemblages that include edge-ground stone axes are those classified as types E, F and G. In Japan, types E and F are called trapezoids and type G is called side scrapers. Types B and C in Fig. 11 are called backed points (knife-shaped tools) and are the main types in the LUP; however, they are not present in the eEUP. The assemblage of types D, E, F and G from the Hinatabayashi B site is a good reference for this early period (Fig. 12).

Yamaoka's (2010) use wear analysis of the type E stone tools from the Doteue site identified breakage suggesting stabbing behavior. Based on this, Yamaoka interpreted these as hafted tools for a stabbing activity. In other words, the Doteue type E tools appear to have been some form of hunting spear. In contrast, use wear analysis of the type E tools from the Hinatabayashi B site identified striations and luster characteristic of tools used for cutting meat or hide (Fig. 13), suggesting these type E tools were used as knives (Tsutsumi, 2006). Use wear analysis has not been conducted on type F and type G tools, but the pointed form of type F tools suggests they were used for a stabbing activity, and the presence of the blade on the side of the type G tools suggests they were used for cutting. The early *Homo sapiens* in the Japanese islands had axes for felling trees and working wood, and trapezoids for hunting activities and for processing hide and meat.

During the time of MIS3, woolly mammoth (*Mammuthus primigenius*) were present in Hokkaido, and Naumann's elephants (*Palaeoloxodon naumanni*) and Yabe's giant deer (*Sinomegaceros yabei*) were present in Honshu (Takahashi, 2007; Iwase et al., 2010). However, there is no direct evidence, such as kill sites with eEUP stone tools, to suggest these large animals were hunted by the early *Homo sapiens*. Further, fossils of these large animals are not common, so it is not clear if these animals existed in numbers large enough to be prey for humans. In short, it is not known whether these eEUP *Homo sapiens* were "big game hunters" or not.

4. Campsites and the development of lithic sources

4.1. Obsidian and the movement of lithic materials

Analysis of the lithic raw materials used by the eEUP peoples with edge-ground stone axes sheds more light on those unique tools. The materials used for the 60 stone axes from the Hinatabayashi B site were tremolite and actinolite. The sources of these materials are approximately 30 km away (Nakamura, 2010). The flake tools from this site were made from fine-grained materials:

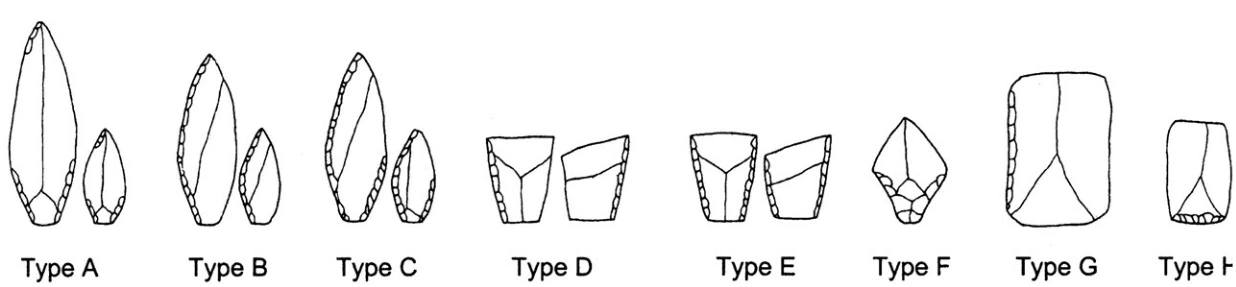

Fig. 11. Types of Palaeolithic flake tools (Yamaoka, 2006).

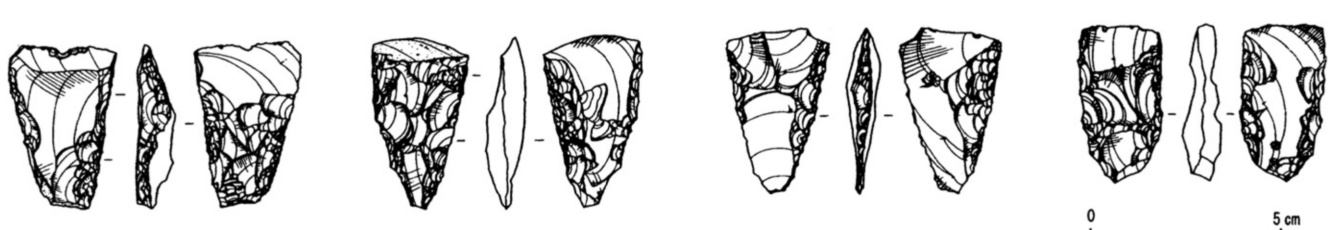

Fig. 12. Type E flake tools from the Hinatabayashi B site (Tani, 2000).

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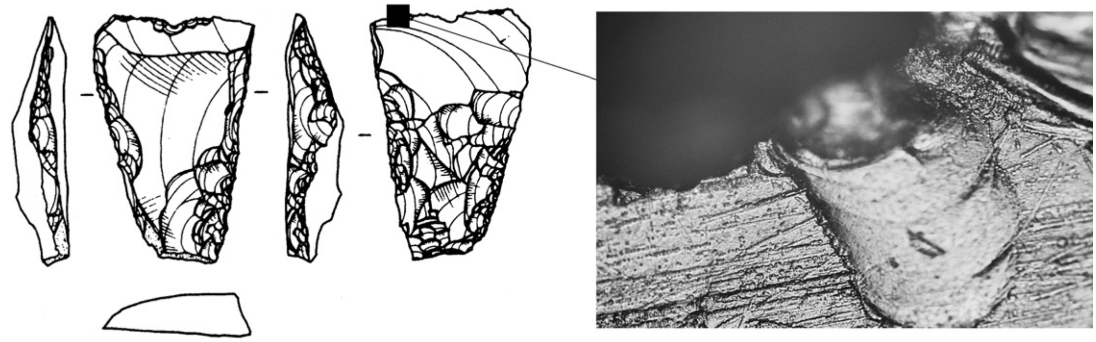

Fig. 13. A type E flake tool from the Hinatabayashi B site showing use damage (Tsutsumi, 2006).

obsidian, chalcedony and andesite. The eEUP *Homo sapiens* groups were the first humans to find and extensively exploit obsidian sources for making tools with extremely sharp cutting edges. In Japan, obsidian sources are limited to well-defined locations in volcanic belts. The exploitation of these sources shows that the humans had detailed information on lithic sources. X-ray fluorescence analysis can determine exact sources of obsidian artifacts, allowing study of how eEUP humans exploited this material. Both inland and coastal sites: Hinatabayashi B, Yokohari Maekubo, Doteue and Umenokizawa, were investigated. The results of source analysis of obsidian artifacts from these sites are given in Table 2, and interpretation of exploitative patterns is shown in Fig. 14.

Source analysis was conducted on 877 obsidian artifacts from the Doteue site on the Pacific coast (Mochizuki et al., 1994). Of these, 406 (46%) were from the Hakone source 20 km from the site, 275 (31%) were from the Amagi source 40 km from the site, and 125 (14%) were from the Kozujima source on Kozu Island in the Pacific Ocean about 100 km from the site. Even assuming a maximum sea-level drop of 140 m at the LGM, Kozu Island was not connected to Honshu by land. The Doteue obsidian from the Kozujima source is indirect evidence that the *Homo sapiens* at this early date were capable of crossing ocean waters. Yamada (2006) considered that this is evidence that the edge-ground stone axes were used, at least in part, for producing some kind of watercraft. The Umenokizawa site is only 3 km from the Doteue site. Of the 345 obsidian artifacts from Umenokizawa, 252 (73%) were from the Hakone source, but only 1 piece was from the Kozujima source (Mochizuki, 2009). Exploitation of obsidian sources clearly differs from site to site.

Three obsidian artifacts made of Kozujima obsidian were identified at the inland Yokohari Maekubo site, 200 km from the source (Mochizuki, 2000b). The number is small but it shows obsidian was transported far inland. Additionally, 103 obsidian artifacts (78%) were from the inland Suwa source about 50 km from the site. In contrast, no Kozujima obsidian was identified at the Hinatabayashi B site 300 km from that source, but 3388 obsidian artifacts (69%) were from the Wada source 80 km from the site (Mochizuki, 2000a).

This evidence of the movement of obsidian suggests several interpretations – the routes along which groups moved, inter-group exchange networks, or resource exploitation territories. This evidence from a high-quality resource found only at very specific locations also shows the modern human behaviors of over-water travel and refined resource exploitation logistics.

Table 2
Sources of obsidian from early Early Upper Palaeolithic sites.

Obsidian Source	Upper Palaeolithic site				
	Hinatabayashi B	Yokohari Maekubo	Doteue	Umenokizawa	Kamibayashi
Wada	3388	3		4	9
Suwa	34	103	66	2	314
Tateshina	73	7	5	23	22
Hakone			406	252	2
Amagi			275	7	1
Takaharayama					17
Kozushima		3	125	1	10
Other		1			
Unkown	45	15		56	7
Total	3540	132	877	345	382

4.2. Circular campsites

The spatial distribution of stone artifacts and tool production debris in eEUP sites commonly manifests a clear circular pattern. This distribution pattern certainly has some relationship to the structure of the camps themselves. It is possible to imagine these artifacts were discarded beside the various “tents” (shelters) that made up the camp. It is then possible to go from this evidence to a reconstruction of the camp and the number of “family tents” that were set up there. For example, a 50-m diameter circle of artifacts was unearthed at the Shimohure Ushibuse site in central Honshu (Kosuge, 2006). This distribution pattern suggests about 20 “tents” arranged around a central open space (Fig. 15). The 80 × 50-m oval at the Kamihayashi site on Honshu (Idei, 2004) is the largest circular distribution of artifacts yet discovered. In the central area of

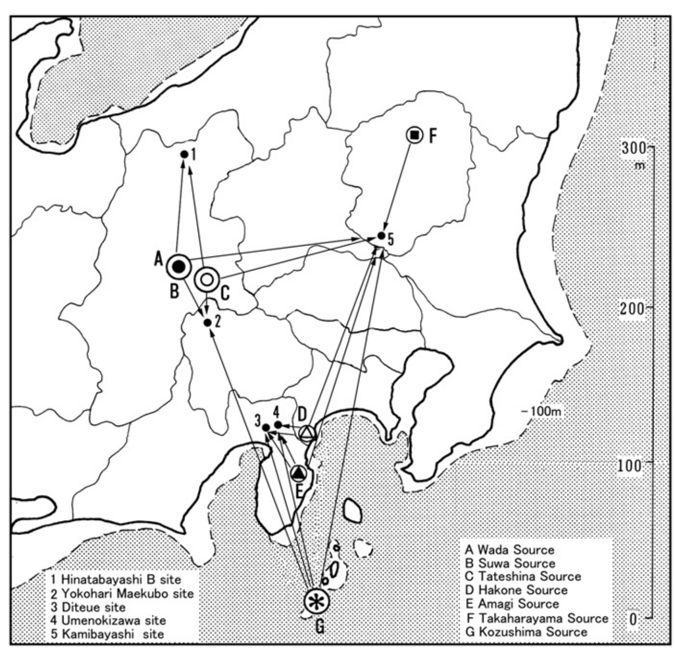

Fig. 14. Obsidian sources and eEUP sites exploiting obsidians in central Honshu.

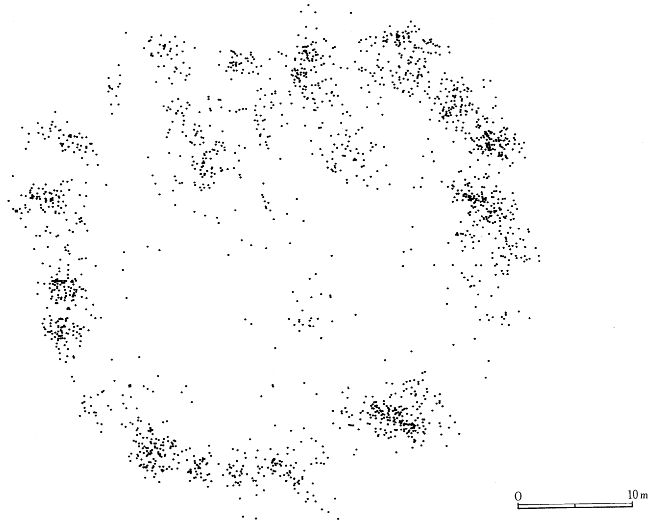

Fig. 15. The circular distribution of artifacts in the Shimofure Ushibuse site (Kosuge, 2006).

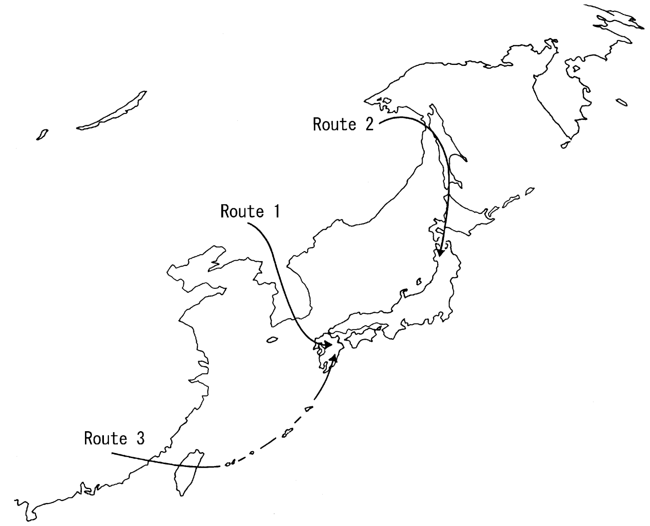

Fig. 17. Routes of *Homo sapiens* entering the Japanese archipelago (the earliest *Homo sapiens* entering the islands most likely used Route 1).

the Hinatabayashi B site, excavation revealed a 30-m diameter circular spread of 9000 stone artifacts. These varied sizes of artifact clusters (Fig. 16) suggest varied sizes of the human groups that occupied the sites. These groups would have needed to clear a large circular space for the camp and produce materials for constructing their shelters. These are activities – felling trees and producing wood construction materials – for which the edge-ground stone axes would have been very suitable, or indispensible.

Whatever the exact interpretation, these circular settlements suggest these prehistoric hunter-gatherers arranged themselves in a circle or ring and carried out various activities together, and that they had cooperative behavior. More specifically, there are several different interpretations. Daikuhara (1990) said these sites represent gatherings for hunting large game. Kurishima (1990) said they were places where the people gathered to exchange resources. Inada (2001) said that these sites represent coalitions against external threats, and Sato (2006) said peoples came together at these sites to reconfirm inter-group solidarity.

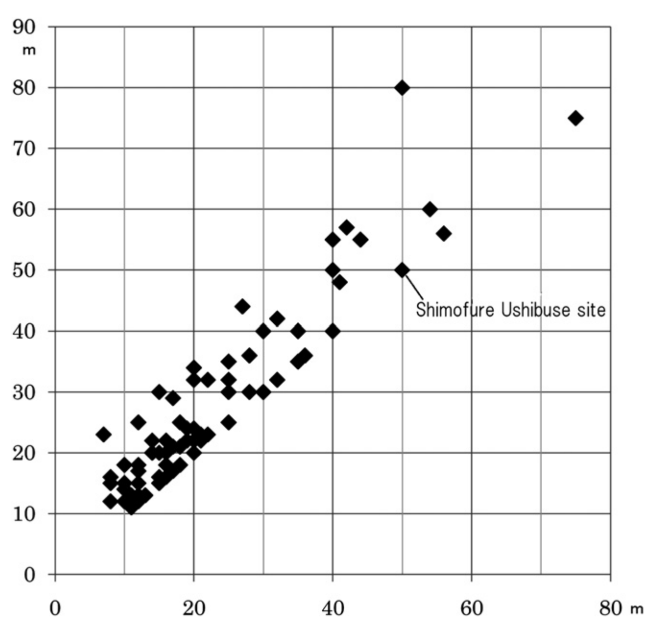

Fig. 16. Scattergram of circular artifact cluster sizes in early Early Upper Palaeolithic sites.

Throughout the entire Japanese Upper Palaeolithic, there is no evidence in the form of durable shelters, large structures, or large accumulations of discarded objects to suggest these Palaeolithic peoples were sedentary. Consequently, their lifestyle appears to have been based on mobility. If so, then these circular settlements would reflect seasonal campsites rather than sites occupied year round.

5. Conclusion

In Japan at present, sites older than 40,000 years, that is, sites preceding the Upper Palaeolithic, are still controversial. None have yet been confirmed, and the author believes that no sites older than the Upper Palaeolithic exist in Japan. However, whatever the final conclusion on older sites turns out to be in the future, at present the oldest sites in Japan are those younger than 40,000 years and yielding edge-ground stone axes. These earliest humans would have been *Homo sapiens* coming out of Africa and across Asia to the Japanese archipelago.

Judging from the dating and distribution of the sites with edge-ground axes, these first settlers in the islands came across water from the Korean Peninsula to Kyushu, then spread eastward through Honshu (Fig. 17-Route 1). Old sites with edge-ground axes have not been found yet in Hokkaido, so it is not certain these early *Homo sapiens* crossed the Tsugaru Strait at the northern end of Honshu Island. Further, the lack of edge-ground axes in Hokkaido seems to rule out a northern entry into the archipelago from Siberia through Hokkaido and then south into Honshu and Kyushu (Route2). At the other end of the archipelago, there also is no clear evidence of common lithic assemblages to suggest that the southern Route 3 from Taiwan via Okinawa to Kyushu was used.

These edge-ground stone axes invented by the first *Homo sapiens* in the Japanese islands were excellent tools for clearing the MIS3 forest and working wood, and, when broken, they could be turned into smaller edge-ground tools for working hide. The "modern human behaviors" of *Homo sapiens* are given as behavioral, economic and technological innovativeness. In the Japanese islands such modern human behaviors are well-represented in the independent invention of edge-ground stone axes, the development of obsidian sources, the crossing of ocean waters to obtain obsidian, and the structuring of circular campsites in accordance with principles of social cohesion.

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